Condition of Indiana Streams and Rivers Using a Probabilistic Monitoring Program

Objective

In 1996, the Indiana Department of Environmental Management (IDEM) began its Probabilistic Monitoring Program as a way to address U.S. EPA's Clean Water Act (CWA) Section 305(b) goal of comprehensively monitoring all waters of the state. The principle outcome of this monitoring program is the State's Integrated Water Quality Monitoring and Assessment Report which includes the 305(b) report and the 303(d) list of impaired waterbodies; those waters that are non-supporting of their designated uses.

The main objective of this program is to produce a statistically valid estimation of the percent of perennial stream miles supporting or non-supporting for aquatic life use and recreational use in the State of Indiana. To produce this calculation, each target site is sampled for concentrations of physical, chemical, and biological parameters and evaluated as "supporting" or "non-supporting" when compared with Indiana's water quality criteria.
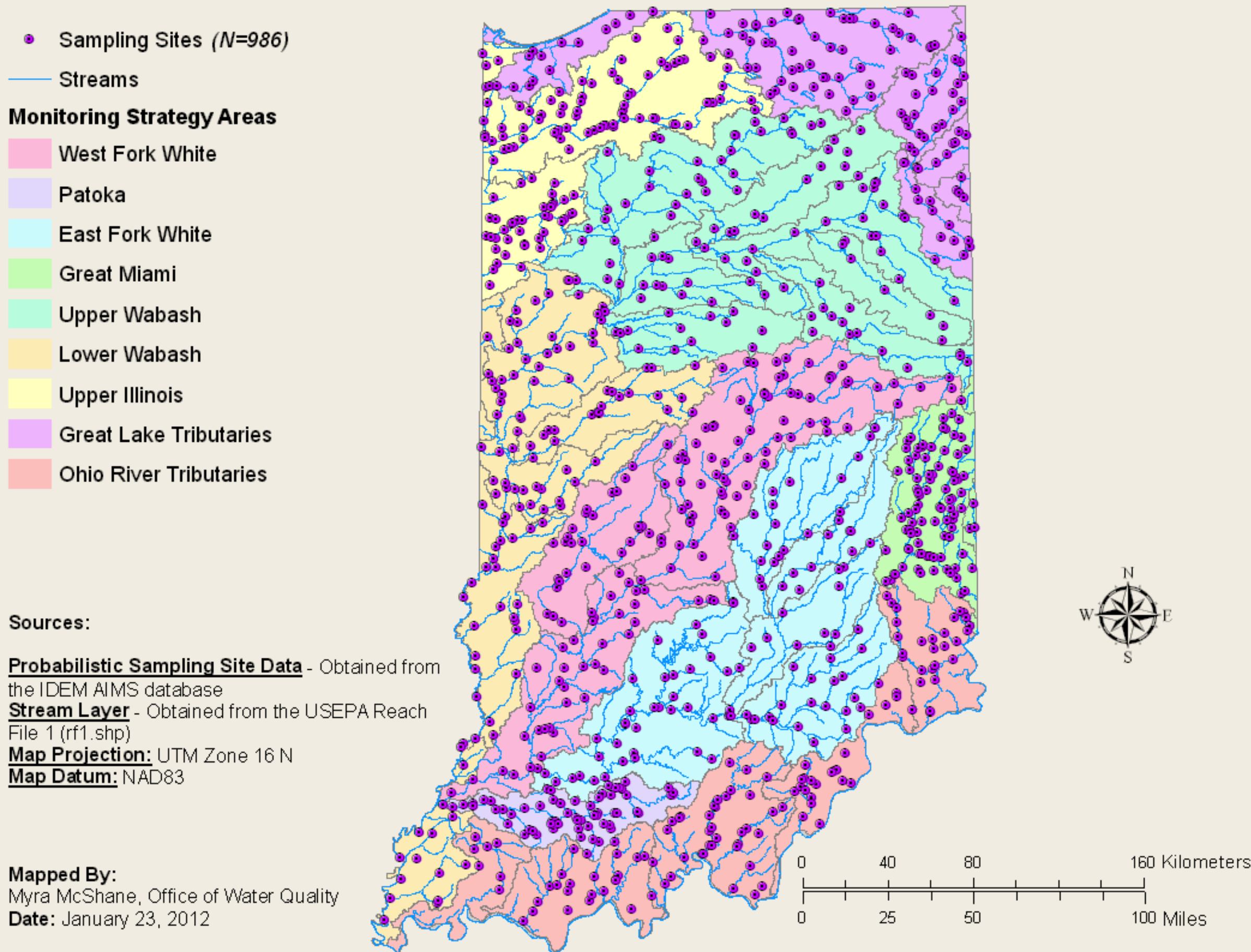

Site Selection

Site selection for the basins are generated by U.S. EPA, National Health and Environmental Effects Research Laboratory (NHEERL), Western Ecology Division, in Corvallis, Oregon, using Environmental Monitoring Assessment Program (EMAP) selection methods. The EMAP design uses a statistically valid number of randomly selected sites to assess and characterize the overall water quality and biotic integrity of the basin of study. To statistically estimate the percent of the basin attaining designated uses with a 95% confidence level, a minimum of 38 probabilistic sites are sampled in the basin of interest.

IDEM's site selection process incorporates a stratified random probability design in order to select an approximately equal number of 1st, 2nd, 3rd, and 4th order and higher streams in the basin. NHEERL provides IDEM with a total of 100 randomly generated potential sites per basin. A "target" site is defined as a sampling point which falls on a perennial stream within the basin of interest. Site reconnaissance of all 100 sites are conducted February through March to determine target or non-target status (i.e. marsh, dry, backwater, etc.), to seek access permission from landowners, and to ascertain safety precautions as well as what equipment is needed.

Figure 1. Probabilistic sites sampled from 1996-2011

Sources:
Probabilistic Sampling Site Data - Obtained from the IDEM AIMS database
Stream Layer - Obtained from the USEPA Reach File 1 (rf1.shp)
Map Projection: UTM Zone 16 N
Map Datum: NAD83

Mapped By:
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Date: January 23, 2012

Methods

In-situ Field Chemistry

Dissolved oxygen, pH, water temperature, specific conductance, turbidity, and dissolved oxygen percent saturation are measured with a data sonde during each sampling event regardless of the media type being collected.

Bacteriological Sampling

Each site is sampled for *E.coli* five times at equally spaced intervals over a thirty day period during the recreational season of April through October. Water samples are collected and processed at the IDEM *E.coli* Mobile Laboratory within the holding time of six hours. To account for the possibility of sites drying up during the course of the thirty day period, field scientists initially sample extra sites to ensure that the goal of 38 total sites will be sampled for all five events.


General Water Chemistry, Metals, and Nutrients

Water chemistry is sampled on three distinct occasions at target sites within the basin, having a minimum time frame of 30 days between each sampling event. Sampling events are usually planned for May, July, and September with October as the deadline for completion. To account for the possibility of sites drying up during the course of the field season, field scientists initially sample the first 45 targeted sites to ensure that the goal of 38 sites will be sampled for all three events.

Phytoplankton and Periphyton

During the third round of water chemistry sampling, phytoplankton and periphyton will be collected. Phytoplankton samples are collected using either the multiple vertices method or the grab sample method. Samples are filtered, foiled, and transported to the laboratory. Periphyton samples are collected from either rocks, sticks, or sand; with preference in that order. Algae is scraped off the surface of the chosen substrate, collected, brought to a volume of 150 mL and preserved with formalin. Samples are kept in a dark cooler and transported to the laboratory for analysis.
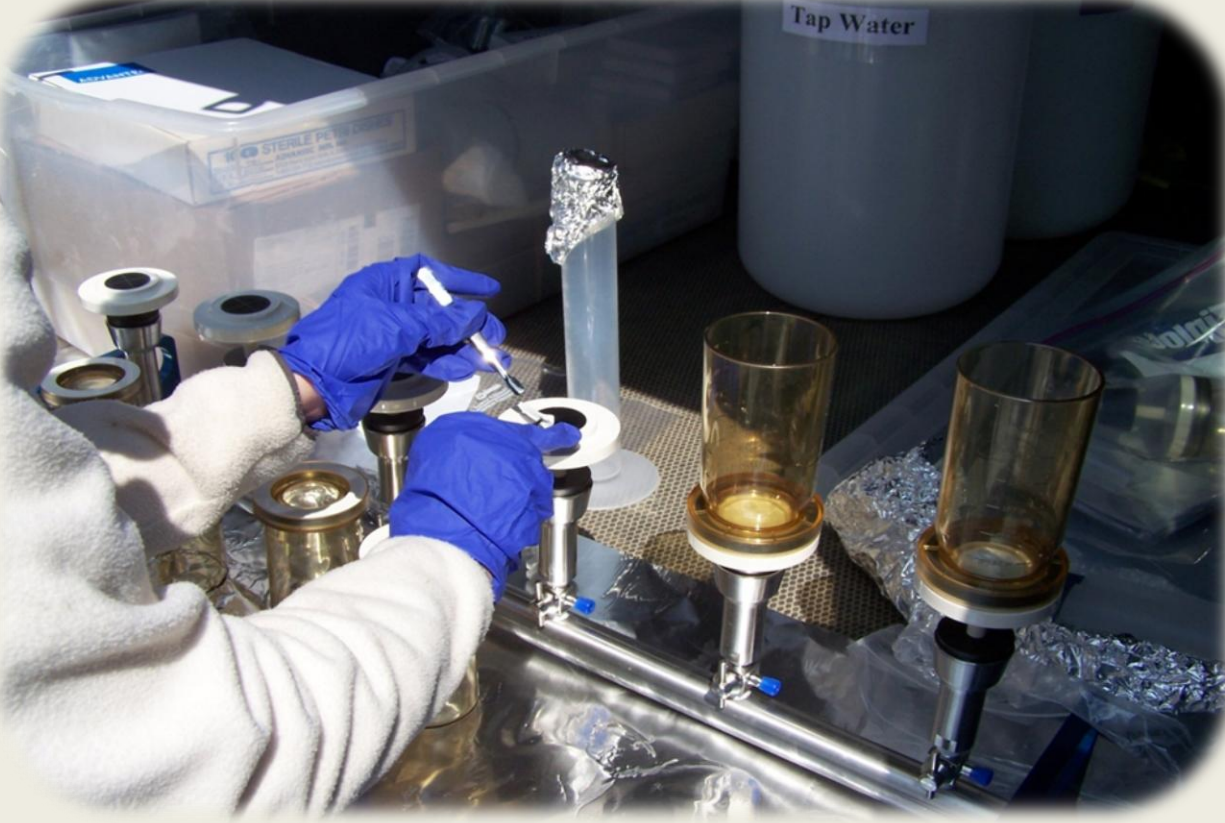
Fish Community Sampling

From July through October, fish community is sampled from 38 target sites in the basin. Fish are sampled in a reach that is equal to 15 times the average wetted width of the stream, with a minimum reach of 50 meters and a maximum reach of 500 meters. All habitat types within the reach are sampled to ensure adequate representation of the fish community present. Various standardized electrofishing methods are used based upon stream size and site accessibility.

Fish collected in the sampling reach are sorted by species, identified, weighed, and measured. Fish that cannot be positively identified in the field, possible hybrids, or individuals with unusual anomalies will be preserved and brought back to the lab for identification. An index of biotic integrity (IBI), which is composed of 12 metrics that assess the community's species and trophic composition, is used to calculate the results of fish assemblage data.


Macroinvertebrate Sampling

Aquatic benthic macroinvertebrate samples are collected once, July through October, at each site using a modification of the U.S. EPA Rapid Bioassessment Protocol multi-habitat approach using a D-frame dip net. This multi-habitat approach is composed of a 1-minute riffle kick sample and a sweep of 50 meters of shoreline habitat. The contents are then elutriated and transferred to a white plastic tray for a 15-minute pick of organisms. Attention to diversity and relative abundance are emphasized during the 15-minute pick. Picked samples are preserved in 70% denatured alcohol and returned to the laboratory for identification to the lowest practical taxonomic level. These lowest taxa samples will be evaluated using the macroinvertebrate IBI.

Habitat Evaluations

Habitat evaluations are completed at each site immediately following macroinvertebrate and fish community sample collections using the Ohio EPA Qualitative Habitat Evaluation Index (QHEI). Since the sampling reach is different for fish and macroinvertebrates, separate QHEI forms are completed for each biological indicator.
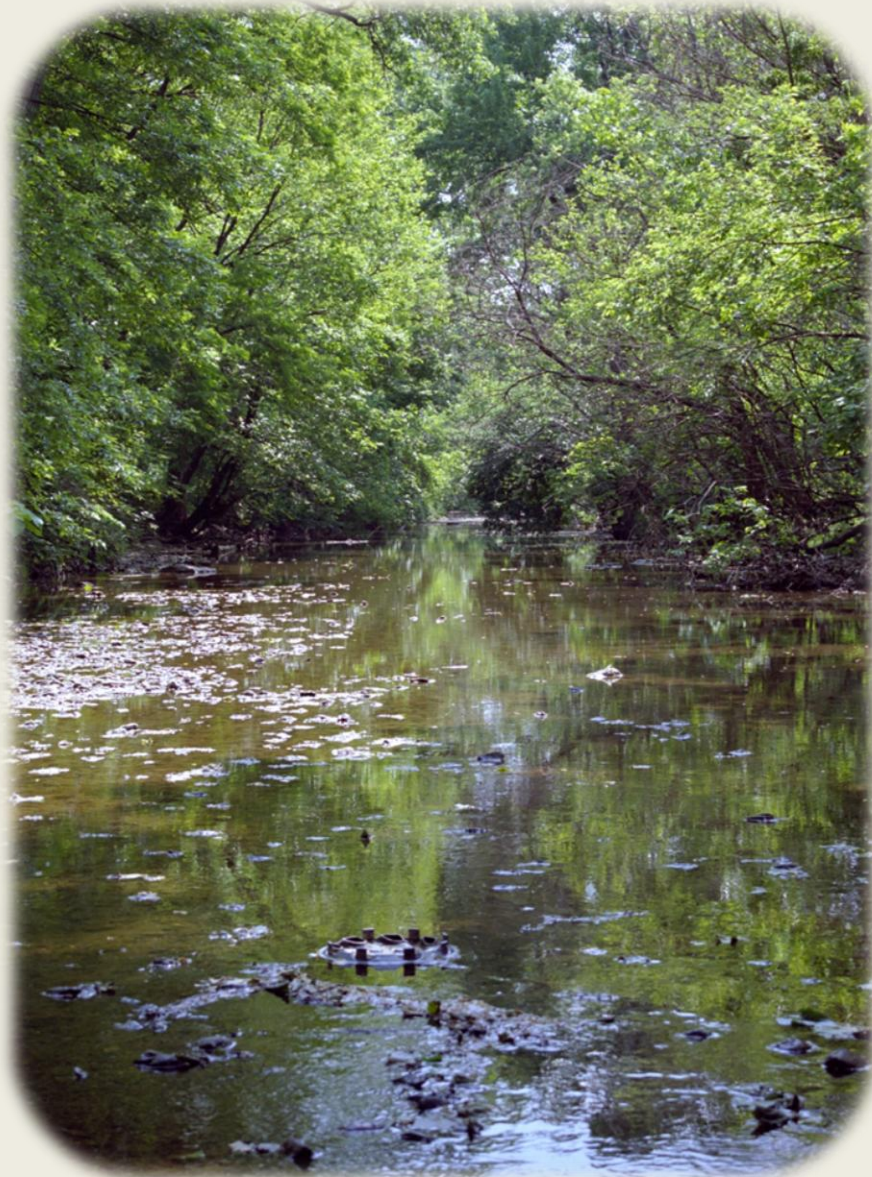

Results

Aquatic life use support decisions consist of independent evaluations of chemical and biological data. A site will be considered non-supporting if one water chemistry parameter is exceeded two or more times with a minimum of three sampling events. In addition, a site is considered non-supporting for aquatic life use when either of the two biological criteria, Fish IBI or Macro IBI, are not met. Therefore, in order for a site to be considered supporting, both water chemistry and biological parameters must be met (Table 1).

Recreational use attainment decisions are based on bacteriological criteria developed to protect primary contact recreational activities. According to these standards, *E.coli* readings in waters of the State of Indiana shall not exceed the water quality criterion (Table 1) during the recreational season of April through October.

Table 1. The Decision Rule for Aquatic Life Use and Recreational Use

	Parameter	Non-supporting Level	Decision Rule
Aquatic Life Use	Water Chemistry	$\geq$ two exceedances of Indiana's WQS [327 IAC 2-1-6 and 327 IAC 2-1.5-8] within a three year period	Supporting if all parameters meet attainment level
Aquatic Life Use	Biological	Fish IBI $\leq$ 35	Non-supporting if any one parameter does not meet attainment level
Aquatic Life Use	Biological	Macro IBI $\leq$ 35	Non-supporting if any one parameter does not meet attainment level
Recreational Use	*E.coli*	>125 CFU/100 mL or 125 MPN/100 mL for 5 sample geometric mean	Non-supporting if the geometric mean is exceeded

Statistical estimations of perennial stream miles supporting designated uses are based on the decision rules for each site sampled. Estimations are calculated using "R" statistical software, available from the U.S. EPA Aquatic Resources Monitoring and Analysis webpage. Figure 2 represents the most current estimations for each designated use in each basin.

Figure 2. Estimation of % Basin Meeting Designated Use
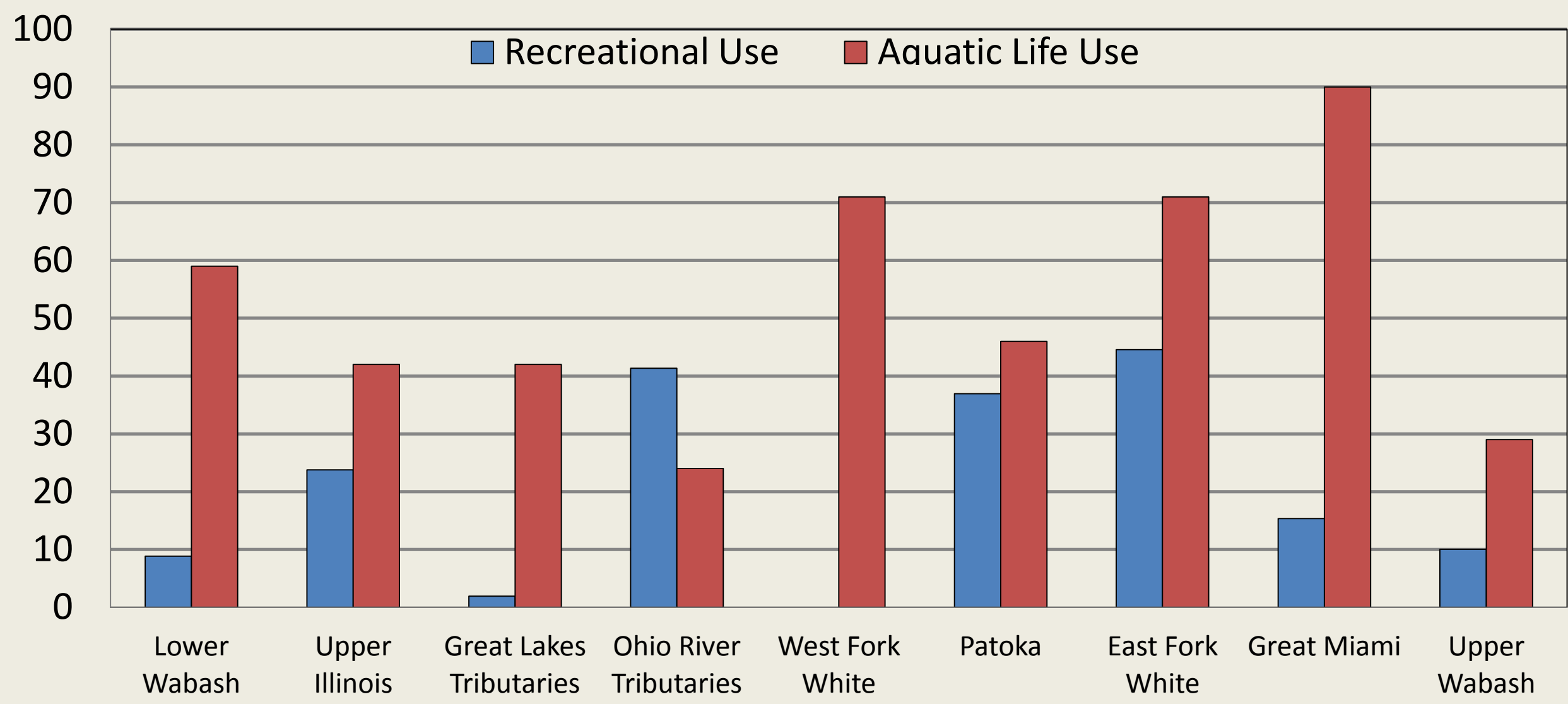
Conclusion/Discussion

Although the probabilistic monitoring program design allows the State of Indiana to provide data that fulfill reporting requirements to U.S. EPA through the Integrated Water Quality Monitoring and Assessment Report, the data are limited. As a result of the sites being random, not revisited, and not collected year round, it is not possible to use the data to determine extent, cause, or source of impairments.

However, data from the Probabilistic Monitoring Program may be useful for municipal, industrial, agricultural, and recreational decision making. Possible examples are use in the Total Maximum Daily Load calculations, National Pollutant Discharge Elimination System permit modeling, and referring smaller watersheds for more intensive targeted sampling.